

A23

(9)



Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number:

0 328 849
A2

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 88810875.0

(51) Int. Cl. 4: **A23G 3/30**

(22) Date of filing: 19.12.88

(30) Priority: 23.12.87 US 137396

(43) Date of publication of application:
23.08.89 Bulletin 89/34

(84) Designated Contracting States:
BE CH DE ES FR GB GR IT LI NL SE

(71) Applicant: **WARNER-LAMBERT COMPANY**
201 Tabor Road
Morris Plains New Jersey 07950(US)

(72) Inventor: Cherukuri, Subraman Rao
10 Jean Drive
Towaco New Jersey 07082(US)
Inventor: Faust, Steven Michael
4-51 Audubon Court
Stanhope New Jersey 07874(US)
Inventor: Orlandi, Daniel Anthony
61-40 149th Street
Flushing New York 11367(US)
Inventor: Zamudio-Tena, Francisco
33 Willow Street
Morristown New Jersey 07960(US)

(74) Representative: Silbiger, Jakob, Dr.
c/o CAPSUGEL AG Münchensteinerstrasse
41
CH-4002 Basel(CH)

(54) Chewing gum compositions having reduced moisture pick-up and method of preparation.

(57) A sugarless, anhydrous chewing gum composition and confectionery coated chewing gum product having low-moisture pick-up and a firm texture which facilitates coating thereof, e.g., a confectionery coating over a pelletized gum form. The composition includes gum base in an amount of from about 18% to about 75% by weight, and a low-moisture pick-up bulking agent which both inhibits moisture pick-up and provides enhanced firmness and texture to the final composition. Preferably, the low-moisture pick-up bulking agent is the isomalt **PALATINIT®**.

EP 0 328 849 A2

CHEWING GUM COMPOSITIONS HAVING REDUCED MOISTURE PICK-UP AND METHOD OF PREPARATION

The present invention relates to improved chewing gum compositions and, in particular, to those which provide chewing gum products having a low moisture pickup while retaining good organoleptic properties and shelf-life. More particularly, the inventive compositions provide for chewing gums which, due to a balance of certain non-hygroscopic bulking agents, prevent moisture absorption in the chewing gum and impart a firm texture to the final gum product. This firmness must be sufficiently hard to facilitate coating the gum piece with a crunchy confectionery composition, but not so hard that the chew is unacceptable from a commercial standpoint.

Chewing gum compositions are, in general, composed of a water-insoluble or base portion and a water-soluble chewing gum portion which primarily contains the sweetness and flavor components. In order to provide an acceptably sweet gum product it is important to consider both of the major components of the overall gum compositions. Thus, in order to retain acceptable sweetness, flavor, and texture while retaining good shelf-life, it is important to provide an environment in which the different gum components maintain their characteristic qualities and are not degraded by moisture or other gum components. Both moisture loss and gain have been known to have particularly harmful effects on the life of gum products.

A non-staling chewing gum composition and method for preparation thereof has been disclosed in U.S. Patent No. 4,579,738 to Cherukuri, et al. which describes a natural sweetener-containing chewing gum composition being substantially free from water and having advantageous process characteristics and shelf-life stability. The chewing gum compositions have exceptionally long period of shelf-life without protective packaging and without the use of humectants as is traditionally used in the art. The chewing gum compositions of the Cherukuri, et al. '738 disclosure include an edible food material which is capable of being formed into particles having microporous channels wherein flavoring liquid can be absorbed and which absorb moisture from the saliva when the gum product is masticated such that the particles swell and impart a juiciness to the gum. This chewing gum composition is advantageous in that it does not require high moisture or moisture-containing additives in order to obtain a viscosity which is suitable and homogenous for both processing and for ultimate gum product satisfaction. As a consequence, ingredients which are normally unstable in the presence of moisture such as aspartame, can be included without serious concern of its deterioration.

In the past chewing gum compositions have been provided with low percentages of moisture in the final product generally by driving off the water once the chewing gum formulation has been made. Thus, for example, the prior art compositions ordinarily contain water and/or moisture-containing ingredients, i.e., sorbitol solution, corn syrup solutions, etc., and would therefore require heating or purification of the compositions to drive off water and obtain a certain moisture content. For example, U.S. Patent No. 4,035,572 discloses a gum based formulation with less than 0.5% moisture. This level percentage of moisture is due to the purification process which removes water and salivant from the gum base.

U.S. Patent No. 4,382,963 involves a low calorie chewing gum which uses polydextrose as the sole soluble bulking agent. The moisture content in the final product is about 1 to 5% and this is obtained by omitting the aqueous component e.g., sorbitol syrups or corn syrups which are normally used in chewing gum products.

U.S. Patent No. 3,262,784 discloses a chewing gum composition which has less than 1% moisture in the final product due to heating between about 170° and 250° F to drive off the water.

U.S. Patent No. 4,150,161 relates to a two component confection having a carbonated candy component and a pliable bubble gum component with each component having a controlled water activity between 0.1 to 0.3 and which is capable of surviving long periods of storage when packaged in a moisture resistant material.

It is also known to provide chewing gum compositions which have low moisture content and/or low moisture pickup during storage. For example, U.S. Patent No. 4,683,138 to Glass, et al. discloses a low moisture, sugarless, center-filled chewing gum wherein a low moisture, liquid center-fill is incorporated into a cavity within a substantially anhydrous chewing gum shell. The Glass, et al. '138 disclosure along with all the references cited therein, each one of which is incorporated herein by reference, are directed to reducing the amount of moisture in chewing gum composition whether its sugar-containing or sugarless gum.

In the case of anhydrous gum compositions, however, there still remains a problem in providing sugarless compositions with low moisture pick-up, especially when humectant or hygroscopic materials are employed as a means of retaining desirable non-staling and flexible characteristics. Generally, sugarless gums contain 65 - 75% of a sugar alcohol such as sorbitol, mannitol, xylitol or mixtures thereof. These materials are moisture absorbent and act like humectants. Thus, sugar alcohol generally cause moisture

pick-up and retention. Additionally, the use of high percentage of glycerin, such as in U.S. 4,574,422, further increases the moisture pick-up potential.

In the above cited disclosures, as well as the state of the art in general, different combinations of gum base ingredients and flavor/sweetener/bulking agent combinations have been tried with varying degrees of success to overcome all the problems associated with providing a sugarless gum with excellent organoleptic properties yet is easily coated with a confectionery coating such that an improved coated gum, e.g., a coated pellet, can be formed.

The present invention provides a unique and highly effective chewing gum composition which can be fine tuned to provide the exact degree of moisture content and pickup desired in the resulting product while retaining acceptable chew properties and facilitating coating if desired. Consequently, the ultimate gum product can be formulated to provide negligible moisture or moisture pick-up throughout the life of the gum while retaining firm structure for gum processing steps, such as coating, and packaging.

Specifically this invention claims a sugarless low-moisture absorbing chewing gum composition comprising in weight percent:

- (a) a gum base in an amount of about 10 to about 75%;
- (b) a low-moisture pick-up (non-hygroscopic) bulking agent in an amount sufficient to provide a textural firmness which remains stable over time and having substantially no moisture pick-up and providing an improved structural gum surface for confectionery coating; and
- (c) a high-intensity sweetener.

The present invention is a sugarless, substantially anhydrous chewing gum composition which is unique in that it provides both low moisture pick-up and firmer texture which result in facilitating coating processes for hard confectionery coated pelletized gum. The composition includes a gum base component which can be present in an amount of from about 10% to about 75% based on the weight of the composition and the composition as a whole should include no greater than about 3.5% by weight of moisture. A key to the present invention is the inclusion of a low-moisture pick-up, non-hygroscopic bulking agent in an amount sufficient to prevent substantial moisture pick-up and maintain a firm, easily coated gum matrix or structure. A balance of firmness in the chewing gum must be maintained to allow for an acceptable chew.

The bulking agent is usually present in an amount from about 10% to about 70% and preferably about 25% to about 65% and most preferably 30% to about 60%. Preferably the bulking agent is an isomalt which is a racemic mixture of alpha-D-glucopyranosyl, 1,6-mannitol and 1,6-sorbitol and having a melting point of 145-150° C. Preferably the isomalt can be present in an amount from about 28% to about 60% by weight of the composition.

The chewing gum composition of the present invention may also include glycerin in an amount sufficient to enhance the non-staling features of the composition. However, if glycerin is added, generally the non-hygroscopic bulking agent must be incorporated in sufficient amounts to counteract the tendency of glycerin to pick-up moisture from the atmosphere. Optionally, a sugar alcohol can also be present in an amount to provide an additional sweetness to the resulting gum product. Generally, the majority of the sweetness is imparted by the high intensity sweeteners rather than the sugar alcohols, because of the latter's tendency to pick-up moisture.

Glycerin can be included in an amount from 0 to about 18%, and preferably from about 10 to about 14% based on the weight of the composition, and the sugar alcohol can be included in an amount of up to about 67% based on the weight of the composition. When the extreme amounts of sugar alcohol is added, the amount of bulking agent must again be increased or adjusted to counteract the hygroscopic tendency of the sugar alcohols.

Furthermore, the composition includes high intensity sweeteners as the predominant sweetener in an amount from about .05 to about 3.0% based on weight and can include flavor agents in an amount of from about 0.05 to about 3% by weight.

Inasmuch as the present chewing gum composition provides an excellent, firm gum structure, it is better suited for, and represents an improvement over the prior art, a coating process which is also contemplated within scope of the present invention. The coated gum confectionery product of the present invention can be either sugar containing or sugarless, and is preferably sugarless. Coated gums are usually in the pelletized form, having a crunchy, hard confectionery (sugar or sugarless) coated thereon.

As a result of the present chewing gum composition and confectionery product, a substantially anhydrous, sugarless gum product can be provided which has a firmer, but acceptably chewable texture, and very low-moisture pick-up, both of which enhance processing and packaging, as well as increasing overall organoleptic acceptability.

For a better understanding of the present invention, together with other and further objects, reference is

made to the following detailed description, and its scope will be pointed out in the appended claims.

The low-moisture sugarless chewing gum composition of the present invention includes gum base in an amount which will vary depending on the type of gum product desired, the consistency desired as well as the elastomeric properties. In general, the base can be included in the final chewing gum composition product and amounts from about 10 to about 75% by weight of the final chewing gum product composition, with preferred amounts of from about 15 to about 40%, and most preferably of from about 23 to about 35% by weight.

In particular, the elastomer component of the gum base of the present invention can be selected from the synthetic elastomers styrene-butadiene copolymer, polyisobutylene, isobutylene-isoprene copolymer (butyl rubber), natural rubber (polyisoprene), as well as masticatory substances of natural origin, such as rubber latex solids, chicle, crown gum, nisparo, rosidinha, jelutong, pendare, perillo, niger gutta, tunu, etc. Mixtures of these materials are also useful.

The resin component, on the other hand, can be selected from polyvinyl butyl ester, copolymers of vinyl esters and vinyl ethers, polyethylene, ethylene-vinyl acetate copolymers, vinyl acetate-vinyl alcohol copolymers, vinyl acetate vinyl laurate copolymers, and in particular high molecular weight polyvinyl acetate, which is at least about 20,000 MWU.

The gum base usually includes an elastomer solvent, which may be selected from terpene resins, such as polymers of alpha-pinene or beta-pinene; rosin derivatives including hydrogenated or partially hydrogenated derivatives, such as the glycerol ester of polymerized rosin, alcohol esters of rosin, such as the glycerol ester of hydrogenated rosin, the pentaerythritol ester of hydrogenated rosin, the glyceryl ester of rosin and mixtures thereof.

The base may include an oleaginous plasticizer, such as hydrogenated vegetable oil, cocoa butter, natural waxes, petroleum waxes such as the polyethylene waxes, paraffin waxes, and microcrystalline waxes with melting points higher than 80°C, or mixtures thereof. These materials may be utilized generally as softeners.

The gum base may include mineral adjuvants such as calcium carbonate, magnesium carbonate, alumina, aluminum hydroxide, aluminum silicate, talc, tricalcium phosphate and the like; as well as mixtures thereof. These mineral adjuvants may serve as fillers and texturizing agents.

Fatty acids may also be included, to serve as softeners, and suitable fatty acids would include stearic acid, palmitic acid, oleic acid, and mixtures thereof. The gum bases also frequently include emulsifiers, particularly those that would be compatible with the vinyl polymer, if included in the base. Particularly, lecithin, glyceryl monostearate, fatty acid monoglycerides, diglycerides and triglycerides, glycerol triacetate, propylene glycol monostearate and mixtures thereof may be used.

The gum base composition may also include conventional additive such as antioxidants, preservatives, colorants and the like. For example, titanium dioxide may be utilized as a colorant, and an antioxidant such as butylated hydroxytoluene, butylated hydroxyanisole, propyl gallate, and mixtures thereof, may also be included.

Naturally, the gum bases may be prepared for a variety of products, including conventional gums and bubble gums, and the invention is not limited to a specific gum base formulation.

Although glycerin is considered to be a humectant, it has been found that it also enhances preservation of the chewing gum composition as a whole over a period of time. Therefore it may be desirable to include glycerin in an anhydrous gum product even though it is desired to avoid moisture pick-up. Accordingly, glycerin may be included in the composition in the present invention preferably in anhydrous form, such as commercially available in the United States Pharmacopoeia (USP) grade. If glycerin is included in the composition it is preferably used in amounts from about 0 to about 18%, and most preferably from about 10 to about 14% based on weight of the composition.

Sugar alcohols useful in the inventive compositions can be selected from the group consisting of sorbitol, mannitol, xylitol and mixtures thereof. While these sugar alcohols can be added as a substantially anhydrous mixture or component to the gum composition, it has been found that the presence of a bulking-amount of sugar alcohol bestows on the composition an unwanted degree of moisture pick-up both, short and long term. Accordingly, while sugar alcohols can be included in the composition of the present invention up to an amount of about 67% by weight of the overall composition, it is only considered to be an optional ingredient which can be used as a sweetening agent if it can be accomplished without significantly increasing the moisture pick-up of the end product.

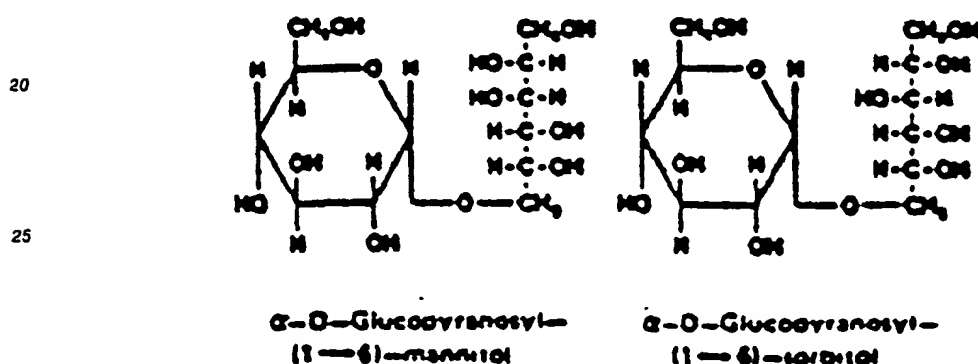
As previously mentioned high intensity sweeteners are incorporated as the primary sweeteners and include saccharine and its various salts such as sodium or calcium salts; cyclamic acid and its various salts such as the sodium salt; the dipeptide sweeteners such as aspartame; amino acid based sweeteners; dihydrochalcone; glycyrrhizin; Stevia rebaudiana (Stevioside); chlorinated sucrose derivatives such as

sucrose; lycasin; and other high intensity sweeteners.

Other conventional ingredients which may be added to the composition of the present invention include a flavor component such as flavoring agents selected from the group consisting of natural or synthetic flavor oils and extracts derived from plants, leaves, flowers, fruits and so forth, and combinations thereof.

5 Representative flavor agents include: spearmint oil, cinnamon oil, oil of wintergreen (methylsalicylate) and peppermint oils. Also considered useful are the natural or synthetic fruit flavors such as citrus oil including lemon, orange, grape, lime and grapefruit and fruit essences including apple, strawberry, cherry, pineapple and so forth. Other ingredients which are useful in the flavor component include citric acid, malic acid, tartaric acid and the like, as well as mixtures thereof.

10 Key, however, to the present invention is the discovery of the ability to use a low-moisture pick-up sweetener-bulking agent which can be combined with glycerin or low amounts of sugar alcohol in a sugarless gum composition to: (1) significantly reduce the moisture pick-up over a period of time and (2) to provide sufficient firmness in textural and structural integrity of the gum surface and matrix to allow for easy coating with confectionery coating compositions. In particular, the bulking agent used in the present
15 invention is an isomalt commercially known as PALATINIT®, or a racemic mixture of alpha-D-Glucopyranosyl 1,6-mannitol and 1,6-sorbitol. The chemical structures are listed below:



While the isomalt PALATINIT® is known to have a relative sweetness when compared to sucrose of only from about 0.50 to 0.60, when it is included in the chewing gum composition of the present invention in combination with high intensity sweeteners, the required sweetness level is obtained.

35 Tests were conducted by using the chewing gum composition of the present invention to compare it with both regular and coated chewing gum confectionery products, and it was found that not only the processing characteristics of the present composition, but the end product of the composition, was superior to known sugarless chewing gum compositions in terms of firmness of texture which allowed for easier processing yet acceptable chew.

EXAMPLES

45 A control sugarless chewing gum composition was prepared using the following formulation.

50

55

CONTROL SAMPLE	
INGREDIENT	PERCENT BY WEIGHT
Gum Base	23.00%
Sorbitol	51.00%
Mannitol	7.07%
High Intensity Sweetener (Saccharin)	0.14%
Glycerin	12.00%
Softener	4.86%
Flavorant	1.75%
Color Agent	0.18%

Additional samples were prepared using the following formulations of the present invention.

INVENTION SAMPLES			
INGREDIENT	SAMPLE 1	SAMPLE 2	SAMPLE 3
Gum Base	23.00%	23.00%	23.20%
Isomalt PALATINIT®	25.50%	51.00%	58.20%
Sorbitol	25.50%	—	—
Mannitol	7.07%	7.07%	—
High Intensity Sweetener			
Saccharin	0.14%	0.14%	—
Aspartame	—	—	0.35%
Glycerin	12.00%	12.00%	13.00%
Softener	4.86%	4.86%	3.65%
Flavorant	1.73%	1.73%	1.50%
Color Agent	0.18%	0.18%	0.10%

Tests were then conducted to determine the amount of moisture absorbed by samples over a period of five weeks at a temperature of 80° F (27° C) and at a relative room humidity of 80%. The results of the tests conducted, which include measuring the amount of moisture picked-up over the respective periods of time are shown in Fig. 1. As can be seen from Fig. 1, the gums containing the PALATINIT® do not absorb as much moisture as the gums containing the sorbitol. In fact, with 100% sorbitol replacement, the amount of moisture picked-up over five weeks is only 11.17%. This is a significant improvement over sugarless, glycerin-sorbitol (without PALATINIT® or a low-moisture, non-hygroscopic bulking agent) containing gums which is as high as 26.6% after five weeks period.

Secondly, an accelerated aging Instron test was conducted to determine the relative hardness of the gum by replacement of the sugar alcohols with PALATINIT® in combination with glycerin. The purpose of these hardness tests was to demonstrate that the inventive compositions retained their firmness over an extended time period such that the coating process can be facilitated. Since the inventive compositions were initially firmer, and due to the presence of the non-hygroscopic bulking agent in the required flavorants, the moisture-level remained relatively level. Moisture pick-up would result in a reduction of the gum's firmness, making coating with a confectionery coating more difficult and less effective.

The equipment used was the Instron Model 1130 with a digital readout from Valtec Associates Inc. Pieces of gum from each of the examples were used. Initially unused gum pieces were stored in a desiccator at 23° C and 23% room humidity. Basically a 3/16 inch plunger was brought to bear against the surface of the gum and a controlled force was exerted until penetration of the surface occurred. The results, which are measured in pounds, are shown in Fig. 2. The results show that the hardness level of the compositions containing PALATINIT® remains higher than conventional gum compositions.

Additionally, chewing gum samples were prepared from the instant invention having candy coated shells. The gum compositions used were made in accordance with the following formulae:

COATED GUM SAMPLES			
INGREDIENT	CONTROL COMPOSITION FOR COATING	SAMPLE 4	SAMPLE 5
Gum Base	23.02%	23.02%	23.02%
Sorbitol	53.40%	29.84%	--
Mannitol	6.28%	--	--
Sweetener- Bulking Agent (PALATINIT®)	--	29.84%	59.68%
Glycerin	12.00%	12.00%	12.00%
High Intensity Sweetener (Saccharin)	0.14%	0.14%	0.14%
Flavorant	2.01%	2.01%	2.01%
Softener	3.15%	3.15%	3.15%

Gum pieces prepared according to the Sample Formulae set forth above were subjected to hardness testing to determine whether or not the product was acceptably soft for the consumer market. The results are set forth in the Table below.

SOFTNESS TABLE						
Sample Coated	Durometer			Instron (lbs)		
	Day 0	Day 1	Day 2	Day 0	Day 1	Day 2
Control	9.65	11.70	12.54	4.05	5.49	5.46
Sample 4	18.55	18.90	20.3	5.58	9.51	9.66
Sample 5	31.70	34.55	34.85	9.04	13.58	13.05

The gum samples prepared in accordance with the invention had a firmer structure which facilitated the subsequent coating process, while also maintaining an acceptably soft texture over several days. It is apparent that the inventive compositions (Samples 4 & 5) are significantly firmer than the control. The resulting pellets formed from the inventive compositions were thus easier to effectively coat and resulted in a higher quality sugarless product.

The samples resulting from the above formulations were then coated by a conventional sugarless coating process such as those set forth in U.S. Patent No. 4,317,838 and U.S. Patent No. 4,238,510, both to Cherukuri, et al. which are incorporated herein by reference. The coated samples were subjected to Panel testing to determine quality acceptance of the final product. The results are set forth below.

EXPERT PANEL TESTING		
Specimen	Sweetness	Crispness/Texture or "Crunch" Test
Coated Control	Good	Good
Sample 4	Good	Excellent
Sample 5	Good	Excellent

As can be seen, the gum product of the present invention provided favorable results when compared to the control sample. Whereas in the past, a crunchy, acceptably sugarless coated pellet gum was not easily formed due to the lack of necessary firmness in the gum composition due to moisture pick-up, the inventive compositions clearly allow for easier processing (coating) while delivering the required crunch and chew expected of coated pelleted gum.

Thus, while there has been described what are presently believed to be the preferred embodiment of the present invention, other and further embodiments will be realized by those skilled in the art, and it is intended to claim all such embodiments as come within the true scope of the invention.

Claims

1. A sugarless low-moisture absorbing chewing gum composition comprising in weight percent:
 - (a) a gum base in an amount of about 10 to about 75%;
 - 5 (b) a low-moisture pick-up (non-hygroscopic) bulking agent in an amount sufficient to provide a textural firmness which remains stable over time and having substantially no moisture pick-up and providing an improved structural gum surface for confectionery coating; and
 - (c) a high-intensity sweetener.
- 10 2. The gum composition of Claim 1 which further comprises a flavor component.
3. The gum composition of the Claims 1 or 2 wherein said bulking agent is an isomalt in an amount of from about 10% to about 70% by weight of said composition.
4. The gum composition of Claim 3 wherein said isomalt is an racemix mixture of alpha-D-glucopyranosyl, 1,6-mannitol and 1,6-sorbitol included in an amount of from about 28% to about 60% by
 15 weight.
5. The gum composition according to anyone of the Claims 1 to 4 wherein said glycerin is included in an amount of from about 0% to about 18% based on the weight of the gum composition, and preferably is included in an amount of from about 2% to about 14% by weight.
6. The chewing gum composition according to anyone of the Claims 1 to 5 wherein said high intensity
 20 sweetener is included in an amount of from about 0.05 to about 3.0% based on weight.
7. The chewing gum composition according to anyone of the Claims 1 to 6 wherein said flavor component is present in an amount of from about 0.05 to about 3.0% by weight.
8. The chewing gum composition according to anyone of the Claims 1 to 7 wherein there is optionally included a sugar alcohol in the amount of up to about 87%.
- 25 9. A confectionery coated chewing gum product comprising:
 - (a) a chewing gum composition comprising a sugarless low-moisture absorbing chewing gum composition comprising a gum base, a low-moisture pick-up (non-hygroscopic) bulking agent in an amount sufficient to provide a textural firmness which remains stable over time and having substantially no moisture pick-up and providing an improved structural gum surface for coating a high-intensity sweetener; and
 30 (b) a hard shell confectionery coating on said chewing gum composition.
10. The chewing gum confectionery product of Claim 9 wherein said coating is a sugarless coating.
11. The chewing gum confectionery product of Claim 9 wherein said bulking agent is an isomalt in an amount from about 18% to about 70% by weight of said chewing gum composition.
- 35 12. The chewing gum confectionery product of Claim 11 wherein said isomalt is a racemic mixture of alpha-D-glucopyranosyl, 1,6-mannitol and 1,6-sorbitol included in an amount from about 28% to about 60% by weight of said composition.
13. The chewing gum confectionery product according to anyone of the Claims 9 to 12 wherein glycerin is included in an amount from about 0% to about 18% based on weight of the gum composition.
- 40 14. Chewing gum confectionery product according to anyone of the Claims 9 to 13 wherein a sugar alcohol is included in an amount of up to about 58% by weight.
15. The chewing gum confectionery product according to anyone of the Claims 9 to 14 wherein said high intensity sweetener is included in an amount from about 0.05 to 3.0% based on weight of said gum composition.
- 45 16. The chewing gum confectionery product according to anyone of the Claims 9 to 15 further including a flavor component present in an amount from about 0.05 to 3.0% by weight of said gum composition.

FIG.1

INSTRON RESULTS

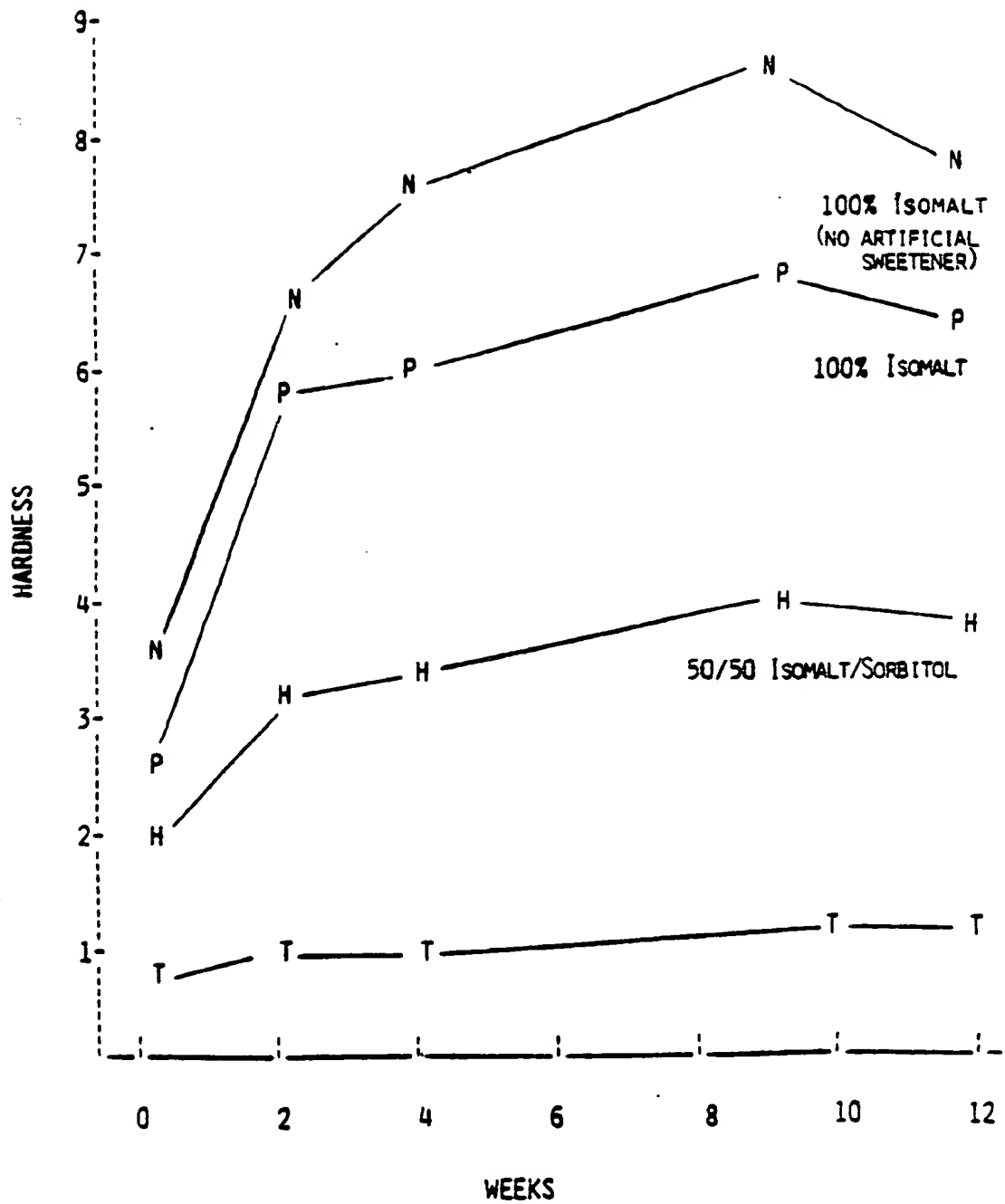


FIG.2

DEWING

